DOCUMENT RESUME

ED 229 728 CS 007 100

AUTHOR Collins, Allan
TITLE Learning to Read and Write with Personal Computers. Reading Education Report No. 42.
INSTITUTION Bolt, Beranek and Newman, Inc., Cambridge, Mass.; Illinois Univ., Urbana. Center for the Study of Reading.
SPONS AGENCY National Inst. of Education (ED), Washington, DC.
PUB DATE May 83
CONTRACT 400-81-0030
NOTE 32p.
PUB TYPE Information Analyses (070) -- Reports - Research/Technical (143)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS *Computer Assisted Instruction; Computer Oriented Programs; Educational Change; *Educational Technology; Elementary Secondary Education; *Microcomputers; *Reading Instruction; *Technological Advancement; Word Processing; *Writing Instruction

ABSTRACT

Recent developments in personal computers will affect the teaching of reading and writing because they offer capabilities that simply were not possible before. For example, an information storage and retrieval system, developed as a "library" for elementary school children, allows them to store and retrieve information under different descriptors. "Dynamic books" have become part of an interactive text that allows the student to browse to find information about particular topics or questions. The browser provides both a table of contents index and a subject index, parts of which can appear on the screen at the same time as the book's text. Through online dictionaries and thesauri, children can merely point to a word they do not understand and its definition can be given to them automatically. Writing coaches are helpful in all phases of writing--helping the student to plan before writing, giving advice as the student writes, and suggesting to the student how to evaluate and revise when a draft is completed. The text editor lets students see the text on a display screen as they type it in and automatically moves the text around to make room for additions, removing extra space caused by deletions. Message systems provide a variety of capabilities for reading and sending messages. And, developments in publications systems enable students to create texts in different formats and with different page layouts. (HOD)

CENTER FOR THE STUDY OF READING

Reading Education Report No. 42

LEARNING TO READ AND WRITE WITH PERSONAL COMPUTERS

Allan Collins
Bolt Beranek and Newman Inc.

May 1983

University of Illinois
at Urbana-Champaign
51 Gerty Drive
Champaign, Illinois 61820

Bolt Beranek and Newman Inc.
50 Moulton Street
Cambridge, Massachusetts 02238

This paper was written under contract with E. H. White and Company as part of the National Institute of Education's Reading Synthesis Project. It was also supported by the National Institute of Education under Contract No. US-NIE-C-400-81-0030. The views expressed in the paper have been shaped by my many discussions with John Seely Brown, Chip Bruce, Dedre Gentner, Jim Levin, and Andee Rubin, and I am grateful to them. I am also very grateful to Cindy Hunt for all her help in typing and revising the paper. Finally I want to thank Judith Orasanu, Chip Bruce, Jim Levin, Arthur Melmed, Andee Rubin, and Steve Weyer for very useful comments on earlier drafts of the paper.

The opinions expressed in the paper do not necessarily reflect the positions or policy of NIE and no official endorsement should be inferred.

Learning to Read and Write with Personal Computers

The invention of the printing press created a revolution in education: the literacy revolution. Before the printing of books, almost no one learned to read and write. Today in literate societies practically everyone learns to read and write. The invention of another new technology, the computer, will have equally profound effects on education. It will affect both what we learn and how we learn. We do not know yet what these changes will be, but we can guess at some of them. Clearly education will become more personalized and rewarding. Children will learn more because their education will be tailored closely to their needs and abilities. Educational activities will be interactive and hence more motivating for children. The changes in education during the computer revolution will probably be as great as those during the literacy revolution.

We are already beginning to experience the computer revolution in education. Personal computers are coming into our homes, schools, museums, and libraries. They provide ways to do a number of things we simply did not have the resources or capability to do before. The educational theories of the best educators and researchers can be embedded in these technologies, and widely distributed as computer programs. The most successful of these will reach every child in America.

Computers have begun to change the teaching of math and science (Abelson & diSessa, 1981; Bork, 1981; Dugdale & Kibbee,

1975; Papert, 1980). Soon they will also affect the teaching of reading and writing, because they offer two kinds of capabilities that simply were not possible before. First, computers can create communication environments where children are reading and writing because they are communicating with children in other places and at other times. This is why reading and writing are important to adults--with computers it is possible to create a world where reading and writing function in the same way for children. Second, computers can provide tools and aids to make the reading and writing tasks that students now perform easier and more rewarding. These can help to compensate for the limitations and difficulties different children have.

I will structure my description of the new capabilities in terms of how a sixth grade girl might prepare a report on a topic like "Why the dinosaurs became extinct." This task involves many of the computer resources now being developed to help students learn to read and write. Thus it illustrates in an integrated way the potential for teaching reading and writing with the new technology.

What she first might do is look for materials about dinosaurs in an information-retrieval system of books and articles. She can access this from her classroom terminal by typing some key words (e.g., dinosaurs, extinction). The system will list the titles and descriptions (including difficulty level) of all the texts on these topics. She can then pick out to read whatever sounds most interesting to her.

As she reads through different books and articles, they function as interactive texts. She can look at the subject index or the table of contents to zero in on specific sections. If she doesn't recognize words, she can point to them and have them said aloud. If she doesn't understand some section, she might request an expanded version of the text that is easier to understand. She can even extract sections of the text to keep in her note file.

There might be an automated dictionary she can refer to by pointing at any word she doesn't understand. The dictionary can provide a definition of the word and examples of its usage in different contexts. Where concrete objects or complex ideas require explanation, the automated dictionary may produce animated pictures of the words being explained. For example, "stegosaurus" might be shown defending himself against an attacker to illustrate the use of his heavy plates; "blood circulation" might be illustrated by showing how blood flows through the circulatory system of some animal.

When she has read through all the materials about dinosaurs that are relevant to why they become extinct, she might call upon a writing coach to help her plan what to write. She could get advice on what kind of ideas to include in an explanatory report. She could make notes for her essay and the system could make it easy to rearrange and organize her notes into an outline. It could even prompt her to consider possible arguments and counterarguments about why the dinosaurs disappeared.

When she is ready to prepare her report, she uses a text editor to type in new material and to expand and rearrange the notes she made during her reading. She can insert pieces of text she extracted from other sources. She can emphasize the key ideas in each sentence and paragraph by using italics or boldface fonts. She can even draw pictures to accompany her text using a graphics editor. These might all be part of a text editor designed especially for children.

When she has finished a first draft, she can have an editorial assistant read through her text to make suggestions about revisions. The assistant can check for spelling and punctuation errors of certain kinds. It can evaluate the style of the sentences. For example, it might comment if the text is too wordy, or if the sentences run on too long or lack variation in style. It can even make suggestions about how to revise the text to be more readable.

After revising her text, she might send copies of it to other students around the country for their comments using a message system. She might belong to a group such as a dinosaur club, made up of students who are interested in dinosaurs. The others could read her piece, and give her feedback on what they like about it and what other ideas she might want to include. If they notice any factual errors or typographical errors the editorial assistant missed, they would point these out. They might even send her copies electronically of things they had read

that they thought she ought to include in her discussion. In some sense they would function as experts reviewing a scientific paper.

Finally, when she has made all the corrections she wants, she might publish her article in a class newspaper or a book about dinosaurs using a publication system. A publication system sets up articles in the proper format for students, prompting them for any missing parts (like a byline, or an index). With it they can produce multiple printed copies to distribute to students, parents, or friends. School or class newspapers in elementary schools may become a medium of communication based on such publication systems.

In the rest of the paper I will describe current developments toward building each of these kinds of systems. The descriptions are meant to give some idea of what possibilities exist given the new technology.

Information Retrieval Systems

At Bolt Beranek and Newman, as part of the Quill project for the Department of Education, Bruce and Rubin (Collins, Bruce, & Rubin, 1982; Rubin, in press) have developed an information storage and retrieval system called the Library for elementary school children. The Library lets students store and retrieve information under different descriptors. For example, fourth graders in Brookline, Massachusetts used the Library to create a

file of game reviews. In their file, a description of each game is stored under several keyword descriptors: e.g., video, arcade, home, board, sports, electronic, indoors, difficult, far out, loony, etc. If someone wants to find out about a "board" game or a "far out, electronic game," they specify those descriptors and the system will list all the games by name fitting the descriptors. To read the description for any game, they type in the name of the game, and the full text describing it is printed on the screen. The Library is a general purpose system that can be used to store any kind of information. such as recipes, encyclopedic information, a thesaurus, etc.

Bruce and Rubin plan to have elementary school children create the First Kid's Computerized Library using the Library system. Students would work in groups of two or three to produce entries on different topics, such as why the rainbow has different colors, or how to make chocolate chip cookies. The topics would be those that students were particularly interested in finding out and writing about. They would have to develop different descriptors for their material (e.g., rainbows, colors) and fit them into a general indexing scheme provided in the program. Ideally the computerized Library that students produce will be available to students all over the country through a message system.

Information retrieval systems of this kind will become common in our society as computers enter homes and libraries. So

children will be learning how to find and use information stored in such systems. But the Library can perform other functions for the children using it: (1) it provides easy access to information that may be useful in their writing for different classes, (2) it is a communication environment, where meaningful reading and writing occurs with peers, and (3) it can be a record keeper that maintains a portfolio of students' work organized by topic, date, author, etc.

Interactive Texts

Steve Weyer (1982) has put a social studies text book on computer at the Xerox Palo Alto Research Center. His goal was to develop the first dynamic book. The central element of Weyer's dynamic book is a browser that the reader can use to find information about particular topics or questions. The browser provides both a table-of-contents index and a subject index, parts of which appear on the screen at the same time as the book's text. If the reader selects a topic in the subject index to read about, the text automatically moves to that section, and the headings for the table of contents reset themselves around the piece of text shown. The words selected in the subject index are automatically highlighted in the text shown. In a similar way, the text changes as the reader browses through the table of contents. Weyer sees dynamic books as being used to find information about topics without reading through the entire text. But this first attempt really only scratches the surface of what can be done with interactive texts.

Another kind of interactive text is being developed by George McConkie at NIE's Center for the Study of Reading at the University of Illinois. When readers cannot recognize a word in the text, they touch the word on the screen and the system will say the word aloud, at the same time underlining it on the screen. In this way the reader gradually comes to be able to recognize any words that are difficult for them personally. McConkie has so far only tried the system with semi-literate adults on a voluntary basis. He has put in texts that these adults would like to be able to read, and so they are improving their sight vocabulary in the context of reading things of interest to them. The same technique should work with young children who have only a small sight vocabulary.

Interactive books may change the nature of reading to be more like conversation (Rubin, 1980). For example, an interactive book can ask questions to make sure readers understand what they have read (Anderson & Biddle, 1975). If readers fail to understand something, the book might expand the text to explain things in simpler terms. In fact, any text could be written at several levels of difficulty or detail. More difficult texts would assume more familiarity with basic concepts. The reader could choose what level of difficulty or detail to tackle. Alternatively, the computer could estimate readers' sophistication by their ability to answer different questions, and present the text best geared to the readers' prior knowledge. This kind of gauging of the student's sophistication

is what teachers do in conversation (Collins, Warnock, & Passafiume, 1975).

With an interactive book, when students do not understand some word or sentence, they might push a question key to ask what it means. This serves the function of a puzzled look or a "huhh" in conversation. If the text has an expanded version this can be given to the student. Alternatively, if there is an online dictionary, the difficult words can be defined. Researchers are just beginning to explore how such interactive books might best respond to readers' needs.

An Automated Dictionary and Thesaurus

George Miller (1979) at Princeton University has been exploring the possibilities of an automated dictionary and thesaurus for children to use. As an online aid in reading and writing, it would be much easier to use and would offer new capabilities not possible with a printed dictionary or thesaurus. For example, if readers do not understand a word, with an online dictionary they do not have to stop, go get a dictionary and look it up. They can merely point to the word with their finger, and its definition could be given to them automatically.

In writing, when you don't know how to spell a particular word, you can type in the parts of the word you are sure about (e.g., th-gh) or your best guess (e.g., thogh). In either case the system suggests different possibilities to choose from. If

you are not sure of the meaning or use, you could then ask for the word's definition. If you are not sure of pronunciation. the system can say the word for you. With an automated thesaurus, you could then ask for words that are similar in meaning to see if you like any of them better. Their definitions too would be available, if you were not quite sure what they mean. Such a system would make it much more likely that you would find the best word in a given context.

Lawler and Papert (1982) have developed the automated dictionary idea in terms of how it might be most useful for pre-readers. What they plan to do is to tie the computer to a video disc that has a picture dictionary in it for preschoolers to explore word-picture correspondences. Action terms might be represented by motion sequences. They envision different ways children might use such a device:

Browsing. The children could type in letters (e.g., DUK), and the entry with the closest match in letters would be shown (e.g., a duck). They could move back or forth alphabetically from any entry by pushing a back arrow or forward arrow key. Keying a single letter would start at the set of entries under that letter (e.g., R might put them at the entry for rabbit).

Look up. The children would be able to scan quickly through entries to find what they want and stop there. Entries might be grouped by conceptual categories as well as letters, so that children could look more slowly through animals or human actions for an entry.

Labelling. Children could make up their own labels for entries, so they can later retrieve them by the names they make up. Children would begin to learn how to create labels they could remember later, and how to use modifiers to differentiate similar entries.

Automated dictionaries of the kind we've described would be powerful tools in both reading and writing. But they will have to be tailored to people at all different ages. In the long run they will be integrated with many different kinds of systems, and will be used in ways never dreamed of for printed dictionaries.

Writing Coaches

A writing coach can prompt writers when they are getting started. In an Oceanside, California classroom, Levin, Boruta, and Vasconcellos (in press) provided a variety of prompts and models for children to use in composing. For example, in one case they provided a basic story structure requiring only that children fill in the blanks in "mad-lib" style:

ONCE A ##### WAS ##### IN a #####.

HE TRIED TO GET ##### THROUGH THE #####.

HE ##### WITH ##### AND #####, BUT HE #####.

One child filled in these blanks to produce the following little "story":

ONCE A FROG WAS IN A POND. HE WANTED TO SEE THE WORLD. HE TRIED TO GET THROUGH THE CAGE. HE TRIED WITH ALL HIS MIGHT, BUT HE CHOULDN'T.

A pair of children filled in the blanks in the first sentence, then finished the story in a completely different way. This writing environment, unlike paper and pencil worksheets, allows them easily to go beyond the support provided.

ONCE AN APPLE WAS COMPUTER IN A CLASSROOM. SHE HELPED TEACH CHILDREN HOW TO SAY SOMETHING. ONE DAY THE COMPUTER BROKE DOWN BECAUSE SHE HAD NO CHILDREN TO TEACH. THE CHILDREN CAME BACK AND PUT A BANDAGE ON HER SCREEN. THE COMPUTER FELT BETTER AND BEGAN TEACHING AGAIN. THE CLASS LIVED HAPPILY EVER AFTER.

There are other kinds of prompts that Levin (1982a) is currently trying out, and that are implemented in a system he calls Interactive Text Interpreter. For stories he may provide the beginning of the story for students to finish. For example, a story might begin "(John) was playing in the woods behind school one day when he found a (little frog). He decided to take

it back to school with him." It is easy to let the student choose the character and the animal the story will be about, while providing defaults if the student can not think of anything.

For poetry Levin provides the set of constraints the child must meet, together with suggestions as to how to fill them and a model of how to do it. For example, Levin provides the following structure for a cinquain:

- 1st line: 2 syllables
- 2nd line: 4 syllables
- 3rd line: 6 syllables
- 4th line: 8 syllables
- 5th line: 2 syllables

The computer also explains "A Cinquain expresses a beautiful thought or describes a scene." Then it asks if you want to see an example. If so, it prints out:

Water
plunging into
crystal waters below
ribbon of cascading power,
beauty.

Then it will prompt the student to type in his or her name and each line of the cinquain by specifying the constraint on that line. When the student is done it prints out his or her cinquain like the model.

Levin has also developed prompts for some of the poetry formats that Kenneth Koch (1970) describes in his book, Wishes, Lies and Dreams, such as the "With a friend" format two girls used to produce the following poem:

With a friend, I can slide
With a friend, I can hide
With a friend, I can walk
With a friend, I can talk

With a friend, I can run
With a friend, I can have fun
With a friend, I can look
With a friend, I can read a book

With a friend, I can hop
With a friend, I can do C. O. P.
With a friend, I can draw
With a friend, I can obey the law.

Another level of prompts (called the Planner) has been developed for the Quill project by Bruce and Rubin using Levin's Interactive Text Interpreter. The Planner prompts students with respect to planning the structure of the kind of piece they are writing. For example, if they are writing a movie review it might prompt them to give the name of the movie and some of the actors and actresses in the movie, what type of movie it is

(comedy, western, mystery, etc.), whether they liked the movie, and the reasons they liked it or didn't like it. It might even encourage students to expand on each of their reasons for liking or not liking the movie. The Planner allows teachers or students to easily create new planners for different genres of writing.

Scardamalia & Bereiter (1981, in press) have studied extensively the difficulties children have in writing and devised methods to help children to write better. A technique they call procedural facilitation has been effective in helping children develop ideas in order to write opinion essays. In it they provide prompts to students such as "A good point on the other side of the argument is . . . ," or "I need some facts to support my argument so . . . " in order to help children in the planning phase of their writing. Based on their success with these prompts in experiments, they have implemented a computerized version called EXPLORE that they are trying out with sixth grade students. These same kinds of prompts might be useful in helping students revise essays they have written earlier, since they force the student to reflect on their arguments.

The kinds of writing coaches we have described will be active in all phases of writing: helping to plan before you write, giving advice as you write, and suggesting how to evaluate and revise your writing when you have completed a draft. Novice writers are particularly weak in planning and revising (Scardamalia & Bereiter, in press; Flower & Hayes, 1980), so that

writing coaches may lead to significant improvements in their writing skills.

Text Editors

In a third/fourth grade classroom in Oceanside, California Jim Levin from the University of California at San Diego has provided students with a text editor he calls the Writer's Assistant (Levin et al., in press). The text editor lets students see the text on a display screen as they type it in. It also makes it easy for students to change what they have typed. They simply press a few keys to indicate what kind of change they want to make, and then type any new text they want to insert. The text editor automatically moves the text around to make room for additions and remove extra space caused by deletions.

To get feedback from the students on Writer's Assistant, Levin posed the question: "How is writing with the computer different from writing with pencil and paper?" A typical response by two of the fourth graders was "Because its funner and easier than writing with pencil and paper. Also it does not hurt your hand." Another response was "You can write faster and better. You also don't need to erace." (Levin et al., in press).

Colette Daiute at Columbia Teacher's College has studied teachers who are using text editors at various places around the country (Daiute, 1982). She has identified several reasons why writing on computers seems to benefit children:

Less concern about making mistakes. When they write by hand, many children crumple up the paper every time they make a mistake. On the computer mistakes can be fixed easily, so the consequences of making mistakes is less devastating.

Texts look better. Children hate messy pages. The computer print increases pride in their work. As one ten year old honestly noted, "The computer makes my writing look better than it is." This increases motivation to write.

Fewer motor-control problems. Some kids have great difficulty with handwriting. The motor control needed to hit keys is much simpler to master, although learning the letter-finger correspondences may take some time. But for children with motor control problems there is no way to make handwriting fun.

Students produce longer papers. Teachers find that students produce longer texts on the computer. Research shows that the more children write, the better they learn to write.

Students revise more. Because text editors make revision easier, students tend to rewrite and experiment more. This helps them discover their awkward sentences and disorganized prose. Daiute even argues that it fosters a greater range of choice and comparison, focusing students more on what they want to say.

In a fifth-grade classroom in Lexington, Massachusetts Laurie Fales found that children working with a text editor paid

more attention to low-level editing skills such as punctuation, capitalization, and spelling, and made greater use of the dictionary. This was especially striking among children with spelling difficulties. Students are more likely to notice errors when writing is printed on the screen rather than hand written. The text editor makes errors more apparent, so children pay more attention to them.

She also found that the children who benefited most were the ones who had problems with neatness and spelling and those who "block" when they write on paper. Unlike most educational innovations, it is not the children who are most gifted that benefit most; rather it is the ones who have the most difficulty in learning to write that benefit most.

From interviews with nine students she learned that eight of the nine preferred writing with the computer (the ninth had lost stories every time, a problem which better-designed text editors can prevent). The students preferred the computer because typing didn't hurt their hands like writing does, because their papers were neater, and because it was easier to fix errors and add ideas. They seemed to think that formatting in the computer made it easier to remember capital letters and to notice spelling errors.

Writing is physically difficult for many children, so they often find typing easier and faster. But it is especially important for children that they don't have to worry about making

mistakes. This is because they can always go back and fix mistakes without copying the whole text over. Some of the pressure is off, and so writing is more fun, and less likely to produce "writer's block."

An Editorial Assistant

At Bell Laboratories in Piscataway, New Jersey, MacDonald et al. (1982) have developed a system, called the Writer's Workbench, that advises writers how to edit their prose. One set of programs gives proof-reading advice. There is a spelling checker that lists all the words it does not recognize. This will find words that are misspelled (e.g., recomended), but it will also find words that it does not know (e.g., Egypt). Moreover, the program will not spot misspelled words that look like another word (e.g., though for through). There is also a punctuation checker that notices unbalanced quotes or parentheses, and uncapitalized first words in sentences, among other things. But there are many punctuation errors it cannot recognize. There are programs that look for split infinitives and words that are repeated by mistake. And finally there is a Diction program that looks for wordy phrases like "bring to a conclusion," and suggests using "conclude," "end," or "finish."

The Writer's Workbench also can perform stylistic analyses, if the writer wants them. It can compute the readability level by several indexes, the average length of words and sentences, and the proportions of simple and complex sentences. It can also

count the frequency of passive sentences, the noun forms of verbs, and the use of phrases such as "there are" or "it is." Overuse of these constructions often leads to wordy, hard-to-understand sentences. Writer's Workbench will even compare the text to well-written texts with respect to these stylistic variables, and give general advice on how the text could be changed to improve it.

Writer's Workbench is one of the first examples of a computerized editorial assistant that can look at your writing and make useful suggestions. It won't find every error, and it will sometimes make bad suggestions. This means that writers can not follow its advice blindly. Because they must decide whether to use any suggestions it makes, it forces them to think about writing style and editing.

Message Systems

Levin (1982b) has set up a message system that lets the third and fourth graders in Oceanside, California communicate to children in a rural school district in Alaska. The Alaskan district has seven schools with a total of 300 students spread over an area about the size of Ohio. Each school has an Apple computer, and they are connected together by phone lines. Schools in both Alaska and California use Writer's Assistant to prepare messages. Then in the middle of the night all the messages from each school are sent automatically to a large computer in Virginia that acts as a mail drop. Some time later

the same night the messages are sent out automatically to the school they are addressed to. Sending messages at night makes the whole scheme quite inexpensive.

Message systems provide a variety of capabilities for reading and sending messages. Messages can be sent in multiple copies by defining a group of people (e.g., Book Lovers) who are to receive a message, or by listing all the people who are to receive the message. When messages are received, students are notified the next time they use the computer. Then they can list the topics and sources for all their messages to see which ones they want to read. Once they've read the message, they can either keep it, throw it away, or send it on to someone else. These are the kinds of facilities found in electronic mail systems.

An interschool message system makes possible a variety of activities where writing for different purposes and in different genres occur naturally (Collins, et al., 1982). One activity Levin plans to develop around the message system are interschool clubs. For example, there might be a Dinosaur Club, where children interested in dinosaurs tell each other about different dinosaurs and their characteristics. Children who like to read might join a book club where they tell each other what they think of the latest book they've read. A joke club might be formed where children send each other any funny jokes they hear. Clubs foster explanatory and descriptive writing. Because the audience

is remote, club members must make themselves understood in writing, or others will always be misinterpreting them and asking what they mean.

A computer bulletin board would function on the school level much like a club with everyone included. Anyone who has an announcement for the school or for a class can insert it onto the computer bulletin board. The message would be sent to everyone in the school or class. Announcements could be about upcoming activities children might be interested in, things someone might like to sell or give away, notices seeking someone who would like to do some particular activity, or teacher notices to the class. such as homework assignments and changes in procedure.

Another activity made possible by the message system is Confidential Chat (Collins et al., 1982). It would be a computerized variation of the personal problem solving section that appears in some newspapers. Students can raise problems to be solved, and anyone can send in solutions. The problems can be social problems ("Our classroom is too noisy to be able to study") or personal problems ("My mother won't let me go out after dinner"), or technical problems ("Who knows how to use Writer's Assistant to write an outline?"). All messages can be sent under code names. The authors can make up whatever code names they like, and can change them as frequently as they like. Confidential Chat encourages children to write problem descriptions and come up with possible solutions in writing.

Collins, Bruce and Rubin have developed a reading and writing game, called Ice Cream Price Wars, designed around the message system developed for the Quill project (Collins et al., 1982). The game is an extension of the Lemonade Stand game developed by the Minnesota Educational Computer Consortium. Students in a classroom will be divided into groups, each of which runs an ice cream stand. All communication within and between groups is by typed messages. Each stand starts with $100 to spend in the game. Once a week each group must decide by consensus how many ice cream cones to make (at 5 cents each), what price to charge for their cones, how many advertising signs to make (at 10 cents each), and what the advertisements should say. The number of cones sold by each stand depends on the price relative to the other stands, and the amount and quality of the advertising, but is limited to the number of cones made. A random element is added by changes in the weather; when it is hot and sunny many more cones are sold than when it is cold and rainy. The discussion within groups and between groups will be by typed messages. Each group will have an assigned code name for communicating within the group that only the teacher knows. The goal will be to argue persuasively for the best strategy. Ice Cream Price Wars is designed to teach persuasive writing, both in discussion with your group and in negotiating with other groups.

Story writing could be encouraged with a message system by starting a Group Epic. This is a story constructing activity,

where a student or teacher starts a story, with a beginning episode that has the potential for leading to a long adventure. Anyone can add a new episode to what has already occurred. Announcements would go out to all the Group Epicures whenever a new episode has been added. At any time, anyone can read a group epic, or add to it, or change it.

Message systems are becoming widespread in our society, carrying electronic mail between businesses and universities. In learning to use a message system, children will be preparing for a society where they will be commonplace. But more important, message systems, when they interconnect different schools, create an environment where written language is the primary means to communicate. This does not happen within a class or school, because it is always possible to talk to the other person. They provide a natural way to make reading and writing as functional for children as it is for adults.

Publication Systems

The third/fourth graders in Oceanside, California used a publication system in Levin's (Levin et al., in press) Writer's Assistant to produce a class newspaper. Students also produced letters during the year that they sent out to various organizations requesting information. With such a publication system, other media, such as books and memoranda, can also be produced easily.

A publication system (Collins, et al., 1982) enables students to create texts in different formats and with different page layouts. For newspapers, it sets up columns, headlines and bylines, a masthead for the editorial board, an index to sections, and the front page layout. For letters, the system sets up the date, salutation, body, and closing for the student. For books, the system can set up chapters and headings, the table of contents, the title page and dedication, an index, and sections for acknowledgments, a forward, and a description of the author, if they are desired. For memoranda, the system can set up the heading containing To, From, Subject, and Date, and the body. The students can simply choose one of these formats for entering material into the publication system, and queries from the system will prompt the input of the various items.

In Oceanside, students produced several issues of the class newspaper. Everyone was encouraged to produce different kinds of articles for the paper. Articles included class news items, book reviews, poems, stories, sports reports, notices, etc. Each article had a headline and a byline. The articles could be written in groups or alone. The teacher also produced articles. Models of each kind of text were available for reference if the student wanted to use a model.

In producing a newspaper, editors could be assigned to each section of the newspaper to check over each article, and either fix it themselves or have the author fix it. Editors would also

be responsible for page layout. There could be a managing editor who decides on overall layout and checks with editors about each section. Editors for each section should be listed on the paper masthead. An emphasis on editing will foster a concern with ways to improve original drafts of text.

Students could also use the publication system to produce different kinds of letters. The system can provide models of different "genres" of letters, e.g., the invitation. the request letter, the thank-you letter, and the social letter (i.e., interesting things that happened to me since I last saw you). Students can be encouraged to write and mail at least one letter in each genre. The invitation could be for a class party, a performance, or an open house. The request letter can go to schools or public institutions to ask for information or materials of some sort, particularly with respect to preparing entries for the Library. The thank-you letter can go to someone for a gift, or to a public institution thanking them for something they did (e.g., a television show, or to another class for their performance). The social letter could go to someone the students likes, who he or she hasn't seen for a while (with an explanation of how the letter was produced).

Within a publication system books can also be produced by an individual or groups of students. A book could be a story, a biography, a book about some topic (e.g., dinosaurs, cars), a book of poems, a book of jokes, a folktale retold, etc. Where a

graphics program or tablet is available, the students can even input pictures to go into their book. When the book is finished they can make multiple copies to give to their family and friends.

Teachers have known for years that newspapers, letters and books are effective ways to motivate students to write in a variety of genres. But the computer adds another dimension. The children get to see their names and texts nicely laid out in print. They can produce as many copies as they like and distribute them to parents and friends. In time children's newspapers may even become a real communication medium for elementary schools.

Conclusion

The computer heralds a new kind of learning in our society. The computer creates environments where reading and writing are instrumental to the goals of children. It can provide various aids to students in their reading and writing that remove the frustrations and compensate for the deficiencies that block learning for many students with different kinds of motor, visual, planning or attention difficulties. In such a setting reading and writing are not just for teachers. All the reasons for written communication and for different genres arise naturally in such communication environments.

References

Abelson, H., & DiSessa, A. A. Turtle geometry: The computer as a medium for exploring mathematics. Cambridge, Mass.: M.I.T. Press, 1981.

Anderson, R. C., & Biddle, W. B. On asking people questions about what they are reading. In G. H. Bower (Ed.), The psychology of learning and motivation (Vol. 9). New York: Academic Press, 1975.

Bork, A. Learning with computers. Bedford, Mass.: Digital Press, 1981.

Collins, A., Bruce, B. C., & Rubin, A. Microcomputer-based writing activities for the upper elementary grades. In Proceedings of the Fourth International Congress and Exposition of the Society for Applied Learning Technology, Orlando, Florida, February 1982.

Collins, A., Warnock, E. H., & Passafiume, J. J. Analysis and synthesis of tutorial dialogues. In G. H. Bower (Ed.), The psychology of learning and motivation (Vol. 9). New York: Academic Press, 1975.

Daiute, C. Word processing. Can it make even good writers better? Electronic Learning, March/April, 1982, 29-31.

Dugdale, S., & Kibbey, D. The fractions curriculum. Plato Elementary School Mathematics Project, University of Illinois, 1975.

Flower, L. S., & Hayes, J. R. The dynamics of composing: Making plans and juggling constraints. In L. W. Gregg & E. R. Steinberg (Eds.), Cognitive processes in writing. Hillsdale, N.J.: Erlbaum, 1980.

Koch, K. Wishes, lies and dreams. New York: Random House, 1970.

Lawler, R. W., & Papert, S. The unreachable word. Cambridge, Mass.: Massachusetts Institute of Technology Logo Project, 1982.

Levin, J. A. Microcomputers as interactive communication media: An interactive text interpreter. The Quarterly Newsletter of the Laboratory of Comparative Human Cognition, 1982, (4), No. 2. (a)

Levin, J. A. Microcomputers communication networks for education. The Quarterly Newsletter of the Laboratory of Comparative Human Cognition, 1982, (4), No. 2. (b)

Levin, J. A., Boruta, M. J., Vasconcellos, M. T. Microcomputer-based environments for writing: A writer's assistant. In A. C. Wilkinson (Ed.), Classroom computers and cognitive science. New York: Academic Press, in press.

Macdonald, N. H., Frase, L. T., Gingrich, P. S., & Keenan, S. A. The writer's workbench: Computer aids for text analysis. IEEE Transactions on Communication, 1982, 20, 1-14.

Miller, G. A. Automated dictionaries. Testing, Teaching and Learning. Washington, D. C.: The National Institute of Education, October 1979.

Papert, S. Mindstorms. Children, computers, and powerful ideas. New York: Basic Books, Inc., 1980.

Rubin, A. D. A theoretical taxonomy of the differences between oral and written language. In R. J. Spiro, B. C. Bruce, & W. F. Brewer (Eds.), Theoretical issues in reading comprehension. Hillsdale, N.J.: Erlbaum, 1980.

Rubin, A. D. The computer confronts language arts: Cans and shoulds for education. In A. C. Wilkinson (Ed.), Classroom computers and cognitive science. New York: Academic Press, in press.

Scardamalia, M., & Bereiter, C. Development of dialectical processes in composition. Paper presented at Conference on the Nature and Consequences of Literacy, OISE. Toronto, October, 1981.

Scardamalia, M., & Bereiter, C. Child as co-investigator: Helping children gain insight into their own mental processes. In S. Paris, G. Olson, & H. Stevenson (Eds.), Learning and motivation in the classroom. Hillsdale, N.J.: Erlbaum, in press.

Weyer, S. A. The design of a dynamic book for information search. International Journal of Man-Machine Studies, 1982, 17, 87-107.